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Title: EJECTOR-TYPE REFRIGERANT CYCLE DEVICE

VERIFIED TRANSLATION OF PRIORITY DOCUMENT

The undersigned, of the below address, hereby certifies that he/she well knows both the English and Japanese languages, and that the attached is an accurate translation into the English language of the Certified Copy, filed for this application under 35 U.S.C. Section 119 and/or 365, of:

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[Name of Article]	Specification 1
[Name of Article]	Drawings 1
[Name of Article]	Abstract 1

[NAME OF THE DOCUMENT] CLAIMS

WHAT IS CLAIMED IS:

1. An ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

5 a radiator (13) that radiates heat from the high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in
10 which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have
15 cooling capacity by evaporating the refrigerant;

a first branch passage (17) that branches a flow of refrigerant at a position between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

20 a first throttling means (18) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant downstream of the radiator (13); and

a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (18), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant, wherein

25 a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the first throttling means (18) is provided with a fully opening function, and fully opens the first branch passage (17) when the second evaporator (19) is defrosted.

30 2. An ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

a radiator (13) that radiates heat from high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a first branch passage (17) that branches a flow of refrigerant at a position between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

a first throttling means (180) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant;

a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;

a bypass passage (23) that guides the high-pressure refrigerant discharged from the compressor (12) directly into the second evaporator (19); and

a shut mechanism (24) that is provided in the bypass passage (23), wherein a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and the shut mechanism (24) is constructed to be normally closed, and to open the bypass passage (23) when the second evaporator (19) is defrosted.

3: An ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

a radiator (13) that radiates heat from the high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a first branch passage (17) that branches a flow of refrigerant at a position between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

a first throttling means (180) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant;

a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;

a bypass passage (33) that bypasses the first throttling means (180); and

a shut mechanism (34) that is provided in the bypass passage (33), wherein a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the shut mechanism (34) is constructed to be normally closed, and to open the bypass passage (33) when the second evaporator (19) is defrosted.

4. The ejector cycle according to any one of Claims 1 to 3, characterized by further comprising:

a third evaporator (27) that evaporates refrigerant to have a cooling capability in a temperature zone that is the same as that of the first evaporator (15).

5. The ejector cycle according to Claim 4, characterized by further comprising:

a second branch passage (25) that branches the flow of refrigerant at a portion of the first branch passage (17) positioned upstream of the first throttling means (18, 180) and joins the branched flow of refrigerant to the flow of refrigerant between the refrigerant outflow side of the first evaporator (15) and the suction side of the compressor (12); and

a second throttling means (26) that is disposed in the second branch passage (25) and depressurizes and expands refrigerant,

wherein the third evaporator (27) is disposed in the second branch passage (25) downstream of the second throttling means (26) in a refrigerant flow.

6. The ejector cycle according to any one of Claims 1 to 5, characterized in that

the first evaporator (15) is connected to a refrigerant outflow side of the ejector (14).

7. The ejector cycle according to any of Claims 1 to 5, characterized in that

a third throttling means (30) is provided between a refrigerant outflow side of the radiator (13) and a refrigerant inflow side of the first evaporator (15), and the ejector (14) is provided in parallel with the third throttling means (30).

8. The ejector cycle according to any of Claims 1 to 7, characterized by further comprising:

a shut mechanism (31) that shuts a passage area located upstream of the ejector (14) when the second evaporator (19) is defrosted.

9. The ejector cycle according to Claim 2, characterized by further comprising:

a shut mechanism (32) that shuts a passage area located upstream of the radiator (13) when the second evaporator (19) is defrosted.

10. An ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

a radiator (13) that radiates heat from a high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a vapor-liquid separator (35) that separates the refrigerant flowing out of the first evaporator (15) into vapor and liquid, and stores liquid phase refrigerant and lets vapor phase refrigerant out to a suction side of the compressor (12);

a branch passage (36) that connects a liquid phase refrigerant outlet of the vapor-liquid separator (35) to the refrigerant suction port (14c);

a throttling means (180) that is disposed in the branch passage (36), and depressurizes and expands the liquid phase refrigerant flowing out of the vapor-liquid separator (35);

a second evaporator (19) that is disposed in the branch passage (36) downstream of the throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;;

a bypass passage (23) that guides the high-pressure refrigerant discharged from the compressor (12) directly into the second evaporator (19); and

a shut mechanism (24) that is provided in the bypass passage (23), wherein a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the shut mechanism (24) is constructed to be normally closed, and to open the bypass passage (23) when the second evaporator (19) is defrosted.

[NAME OF THE DOCUMENT] SPECIFICATION

[THE TITLE OF THE INVENTION] EJECTOR CYCLE

[FIELD OF THE INVENTION]

[0001]

5 The present invention relates to an ejector cycle having an ejector that functions as a refrigerant decompressing means and a refrigerant circulating means. The present invention is effectively applicable to, for example, a refrigeration cycle for an air-conditioning and refrigerating device for a vehicle.

[BACKGROUND ART]

10 [0002]

 The applicants propose a vapor-compression refrigeration cycle (ejector cycle) using an ejector adapted as a refrigerant decompression means and a refrigerant circulating means, in patent document 1. In the patent document 1, a first evaporator is located between the ejector and a gas-liquid separator downstream of the ejector, and a second evaporator is located between a liquid refrigerant outlet side of the gas-liquid separator and a refrigerant suction side of the ejector, as one embodiment described therein.

[0003]

 In a JP patent application No. 2004-87066, the applicants propose a vapor-compression refrigeration cycle (ejector cycle) in which a first evaporator is located at a refrigerant flowing-out side of an ejector, a branch passage is branched between a radiator for radiating refrigerant discharged from a compressor and the ejector, a refrigerant flowing-out side of the branch passage is connected to the refrigerant suction port of the ejector, a throttle means is located in the branch passage, and a second evaporator is located downstream of the throttle means.

[Patent Document 1]

 JP Patent No. 3322263

[DISCLOSURE OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

30 [0004]

 However, in the above patent document 1 and the prior patent application, because the refrigerant evaporation pressure of the second evaporator is lower

than that of the first evaporator, the refrigerant evaporation temperature may be operated at a low temperature condition lower than 0 °C. Thus, there is a problem that the cooling performance is decreased due to the frost of the second evaporator. However, the above patent document 1 and the prior patent application do not propose regarding a defrosting means.

[0005]

In view of the foregoing points, it is an object of the present invention to obtain an evaporator defrosting function with a simple structure, in a vapor-compression refrigeration cycle using an ejector, provided with plural evaporators.

[MEANS TO BE SOLVED BY THE INVENTION]

[0006]

To achieve the above object, in the invention described in claim 1, an ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

a radiator (13) that radiates heat from the high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a first branch passage (17) that branches a flow of refrigerant at a position between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

a first throttling means (18) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant downstream of the radiator (13); and

a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (18), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant, wherein

a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the first throttling means (18) is provided with a fully opening function, and fully opens the first branch passage (17) when the second evaporator (19) is defrosted.

[0007]

Thus, it is possible to exert cooling capability in a high temperature range with the first evaporator (15) that is high in refrigerant evaporating pressure and further exert cooling capability in a low temperature range with the second evaporator (19) that is low in the refrigerant evaporating pressure.

[0008]

When the second evaporator (19) is defrosted, the first throttling means (18) is operated to the position in which the first branch passage (17) is fully opened. Thus, the high-temperature, high-pressure refrigerant at the outlet of the radiator (13) can be directly introduced into the second evaporator (19) through the first branch passage (17).

[0009]

Thus, the second evaporator (19) can be effectively defrosted. The first throttling means (18) functions to reduce the pressure of refrigerant in the normal operation. In a defrosting operation, the second evaporator (19) can be defrosted with a very simple construction without adding any special part just by bringing this first throttling means into a fully open state.

[0010]

The refrigerant on the downstream side of the radiator (13) is let into the second evaporator (19) through the throttling means (18). In the normal operation, therefore, the flow rate of refrigerant in the second evaporator (19) can be easily adjusted to a value corresponding to a thermal load by the throttling means (18).

[0011]

"The fully opening function of fully opening the first branch passage (17)"

includes a function of opening the first branch passage (17) while slightly reducing its area, in addition to a function of fully opening it. That is, there are cases where the first throttling means (18) is inevitably so constructed that the first branch passage (17) is opened with its area slightly reduced for manufacture reasons or the like.

[0012]

In the invention described in claim 2, an ejector cycle characterized by comprising:

- a compressor (12) that sucks and compresses refrigerant;

- a radiator (13) that radiates heat from high-pressure refrigerant discharged from the compressor (12);

- an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

- a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

- a first branch passage (17) that branches a flow of refrigerant at a position between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

- a first throttling means (180) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant;

- a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;

- a bypass passage (23) that guides the high-pressure refrigerant discharged from the compressor (12) directly into the second evaporator (19); and

- a shut mechanism (24) that is provided in the bypass passage (23), wherein

a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the shut mechanism (24) is constructed to be normally closed, and to open the bypass passage (23) when the second evaporator (19) is defrosted.

5 [0013]

In the invention described in claim 2, the defrosting means for the second evaporator (19) is changed as compared with claim 1. That is, in the invention of claim 2, when the second evaporator (19) is defrosted, the high-temperature, high-pressure refrigerant on the discharge side of the compressor (12) is directly
10 led into the second evaporator (19) through the bypass passage (23). The second evaporator (19) can be thereby defrosted.

[0014]

In addition, the first throttling means (180) need not be provided with a fully opening function. Therefore, an ordinary fixed throttle or variable throttle can be
15 directly used as the first throttling means (180) without change. The other operation and effects in claim 2 are the same as those of claim 1.

[0015]

In the invention of claim 3, an ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

20 a radiator (13) that radiates heat from the high-pressure refrigerant discharged from the compressor (12);

an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high
25 speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the pressure energy thereof;

30 a first evaporator (15) having a refrigerant outflow side connected to a suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a first branch passage (17) that branches a flow of refrigerant at a position

between the radiator (13) and the ejector (14), and guides the branched flow of refrigerant to the refrigerant suction port (14c);

a first throttling means (180) that is disposed in the first branch passage (17) and depressurizes and expands refrigerant;

5 a second evaporator (19) that is disposed in the first branch passage (17) downstream of the first throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;

a bypass passage (33) that bypasses the first throttling means (180); and

a shut mechanism (34) that is provided in the bypass passage (33), wherein

10 a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the shut mechanism (34) is constructed to be normally closed, and to open the bypass passage (33) when the second evaporator (19) is defrosted.

[0016]

15 In the invention of claim 3, the defrosting means of the second evaporator (19) is changed relative to claim 1, 2. That is, in the invention of claim 3, when the second evaporator (19) is defrosted, the bypass passage (33) of the first throttling means (180) is opened by the shut mechanism (34). Thus, the high-temperature, high-pressure refrigerant at the outlet of the radiator (13) can be directly led into the
20 second evaporator (19) through the bypass passage (33).

[0017]

Thus, the second evaporator (19) can be effectively defrosted. In addition, the first throttling means (180) need not be provided with a fully opening function. Therefore, an ordinary fixed throttle or variable throttle can be used as the first
25 throttling means (180) without change.

[0018]

In the invention of claim 4, the ejector cycle of any one of Claims 1 to 3, further includes a third evaporator (27) that evaporates refrigerant to have a cooling capability in a temperature zone that is the same as that of the first evaporator (15).

30 [0019]

Thus, cooling performance can be delivered in the same temperature zone using the multiple evaporators (15, 27).

[0020]

In the invention of claim 5, the ejector cycle according to Claim 4 further includes: a second branch passage (25) that branches the flow of refrigerant at a portion of the first branch passage (17) positioned upstream of the first throttling means (18, 180) and joins the branched flow of refrigerant to the flow of refrigerant between the refrigerant outflow side of the first evaporator (15) and the suction side of the compressor (12); and a second throttling means (26) that is disposed in the second branch passage (25) and depressurizes and expands refrigerant, wherein the third evaporator (27) is disposed in the second branch passage (25) downstream of the second throttling means (26) in a refrigerant flow.

[0021]

Specifically, as mentioned above, the second branch passage (25) is formed, and the third evaporator (27) can be disposed in the second branch passage (25).

[0022]

According to the invention of claim 6, in the ejector cycle according to any one of Claims 1 to 5, the first evaporator (15) may be connected to a refrigerant outflow side of the ejector (14).

[0023]

According to the invention of claim 7, in the ejector cycle according to any of Claims 1 to 5, a third throttling means (30) is provided between a refrigerant outflow side of the radiator (13) and a refrigerant inflow side of the first evaporator (15), and the ejector (14) is provided in parallel with the third throttling means (30).

[0024]

Thus, it is unnecessary to bring the ejector (14) in charge of refrigerant flow rate adjusting a function for the first evaporator (15) because the third throttling means (30) dedicated to the first evaporator (15) is provided. For this reason, the ejector (14) can be specialized in a pump function for producing a pressure difference between the first and second evaporators (15, 19).

[0025]

Thus, the shape of the ejector (14) can be optimally designed so as to produce a predetermined pressure difference between the first and second evaporators (15, 19). As a result, the ejector cycle can be operated with high

efficiency even if cycle operating conditions (number of compressor revolutions, ambient temperature, temperature of space to be cooled, etc.) fluctuate over a wide range.

[0026]

5 In the invention of claim 8, the ejector cycle according to any of Claims 1 to 5 further includes a shut mechanism (31) that shuts a passage area located upstream of the ejector (14) when the second evaporator (19) is defrosted. Thus, if the second evaporator (19) is defrosted, the flow of high-pressure refrigerant flowing from the refrigerant outflow side of the radiator (13) into the ejector (14) can be interrupted. Therefore, the quantity of the high-pressure refrigerant flowing into
10 the second evaporator (19) can be increased to enhance defrosting performance.

[0027]

In the invention of claim 9, the ejector cycle according to Claim 2 further includes a shut mechanism (32) that shuts a passage area located upstream of the
15 radiator (13) when the second evaporator (19) is defrosted. Thus, when the second evaporator (19) is defrosted, the quantity of high-pressure refrigerant flowing from the discharge side of the compressor (12) into the second evaporator (19) can be increased to enhance defrosting performance.

[0028]

20 In the invention described in claim 10, an ejector cycle characterized by comprising:

a compressor (12) that sucks and compresses refrigerant;

a radiator (13) that radiates heat from a high-pressure refrigerant discharged from the compressor (12);

25 an ejector (14) having a nozzle portion (14a) that depressurizes and expands refrigerant on a downstream side of the radiator (13), a refrigerant suction port (14c) through which gas refrigerant is sucked by the flow of refrigerant jetted at high speed from the nozzle portion (14a), and a pressure increasing portion (14b) in which the refrigerant jetted at the high speed and the sucked gas refrigerant are mixed and the speed energy of the mixed refrigerant flow is converted to the
30 pressure energy thereof;

a first evaporator (15) having a refrigerant outflow side connected to a

suction side of the compressor (12), the first evaporator (15) being adapted to have cooling capacity by evaporating the refrigerant;

a vapor-liquid separator (35) that separates the refrigerant flowing out of the first evaporator (15) into vapor and liquid, and stores liquid phase refrigerant and lets vapor phase refrigerant out to a suction side of the compressor (12);

a branch passage (36) that connects a liquid phase refrigerant outlet of the vapor-liquid separator (35) to the refrigerant suction port (14c);

a throttling means (180) that is disposed in the branch passage (36), and depressurizes and expands the liquid phase refrigerant flowing out of the vapor-liquid separator (35);

a second evaporator (19) that is disposed in the branch passage (36) downstream of the throttling means (180), the second evaporator (19) being adapted to have cooling capacity by evaporating the refrigerant;;

a bypass passage (23) that guides the high-pressure refrigerant discharged from the compressor (12) directly into the second evaporator (19); and

a shut mechanism (24) that is provided in the bypass passage (23), wherein a refrigerant evaporating pressure of the second evaporator (19) is lower than a refrigerant evaporating pressure of the first evaporator (15), and

the shut mechanism (24) is constructed to be normally closed, and to open the bypass passage (23) when the second evaporator (19) is defrosted.

[0029]

Claim 10 corresponds to the thirteenth embodiment shown in Fig. 14. In this case, the branch passage (36) that connects the liquid phase refrigerant outlet portion of the vapor-liquid separator (35) to the refrigerant suction port (14c) is provided, and this branch passage (36) is provided with the throttling means (180) and the second evaporator (19), which are different from claims 1 to 9.

[0030]

With such the cycle configuration, when the second evaporator (19), in which refrigerant is evaporated at a lower temperature than in the first evaporator (15), is defrosted, the high-pressure refrigerant on the discharge side of the compressor (12) is directly led into the second evaporator (19). Thus, the second evaporator (19) can be effectively defrosted.

[0031]

The numerals in parentheses for the above-described means and the means described in Claims indicate correspondence with the concrete means in the embodiments described later.

5

[BEST FORM TO EMBODY THIS INVENTION]

[0032]

(First Embodiment)

10 FIG. 1 illustrates an example in which an ejector cycle in the first embodiment of the present invention is applied to a refrigerant cycle for an air conditioner and a refrigerator for vehicles. The ejector cycle 10 is provided with a refrigerant circulation path 11. A compressor 12 that sucks and compresses refrigerant is disposed in this refrigerant circulation path 11.

[0033]

15 This embodiment is so constructed that this compressor 12 is rotatably driven by an engine (not shown) for a vehicle running through a belt or the like. The embodiment uses as the compressor 12 a variable displacement compressor whose refrigerant discharge capacity can be adjusted through change in discharge volume. Discharge volume of the compressor 12 corresponds to the refrigerant
20 discharge quantity per revolution. The discharge volume can be varied by varying the refrigerant suction volume.

[0034]

The variable displacement compressor 12 is represented by swash plate type, which is specifically so constructed that the refrigerant suction volume is
25 varied by varying the angle of a swash plate to vary the piston stroke. The angle of the swash plate can be electrically and externally controlled by varying the pressure in the swash plate chamber (control pressure) through an electromagnetic pressure controller 12a that constitutes a displacement control mechanism.

[0035]

30 A radiator 13 is disposed on the downstream side of the compressor 12 with respect to the flow of refrigerant. The radiator 13 cools high-pressure refrigerant discharged from the compressor 12 by exchanging heat between the high-pressure

refrigerant and outside air (air outside vehicle compartment) blown by a cooling fan (not shown).

[0036]

5 An ejector 14 is disposed downstream from the radiator 13 with respect to the flow of refrigerant. This ejector 14 is a pressure reducing means that depressurizes refrigerant, and simultaneously a kinetic pump that fluid-transport by the suction of the flow of refrigerant jetted at high speed (refer to JIS Z 8126 No. 2. 1. 2. 3, etc.).

[0037]

10 The ejector 14 includes: a nozzle portion 14a that reduces the area of the passage of high-pressure refrigerant flowing from the radiator 13 and entropically depressurizes and expands the high-pressure refrigerant or the like; and a suction port 14c that is so disposed as to communicate with the refrigerant jet hole in the nozzle portion 14a and sucks refrigerant from a second evaporator 19, described
15 later.

[0038]

A diffuser portion 14b that makes a pressurizing portion is disposed downstream of the nozzle portion 14a and the suction port 14c with respect to the flow of refrigerant. This diffuser portion 14b is formed in such a shape as to
20 gradually increase the area of the refrigerant passage. The diffuser portion 14b functions to decelerate the flow of refrigerant and increase the pressure of the refrigerant, that is, to convert the velocity energy of refrigerant into pressure energy.

[0039]

25 The refrigerant that flowed out of the diffuser portion 14b of the ejector 14 flows into a first evaporator 15. The first evaporator 15 is installed in, for example, an air duct of an air conditioning unit (not shown) in a vehicle compartment, and functions to cool the interior of the vehicle compartment.

[0040]

30 More specific description will be given. Air for performing air conditioning of the vehicle compartment is blown to the first evaporator 15 by an electric blower (first blower) 16 of the vehicle-compartment air conditioning unit. The low-pressure refrigerant depressurized by the ejector 14 absorbs heat from the

vehicle-compartment air-conditioning air and is evaporated at the first evaporator 15. As a result, the vehicle-compartment air-conditioning air is cooled, and the cooling capability is exerted. The vapor phase refrigerant evaporated at the first evaporator 15 is sucked into the compressor 12, and is circulated in the refrigerant circulation path 11 again.

[0041]

A branch passage 17 is formed in the ejector cycle in this embodiment. This branch passage 17 is branched from the refrigerant circulation path 11 between the radiator 13 and the ejector 14, and is joined to the refrigerant circulation path 11 at the suction port 14c of the ejector 14.

[0042]

In this branch passage 17, there is provided with a throttling mechanism 18 that adjusts the flow rate of refrigerant and reduces the pressure of the refrigerant. In this embodiment, the throttling mechanism 18 is constructed of a throttling mechanism provided with a fully opening function. FIG. 2(a) and 2(b) are schematic sectional views illustrating concrete examples of this throttling mechanism 18 provided with a fully opening function. The throttling mechanism 18 is provided with a movable plate member 18c in which a throttle hole 18a, that constitutes a fixed throttle, and a fully opening hole 18b for fully opening the branch passage 17.

[0043]

This movable plate member 18c is so disposed that it is movable in the transversal direction of the branch passage 17 (the direction perpendicular to the direction "a" of the flow of refrigerant). The movable plate member 18c is driven by an electric actuator 18d constructed of a servo motor and the like. FIG. 2(a) illustrates the throttling mechanism in a normal operation in which the throttle hole 18a functions as a fixed throttle. FIG. 2(b) illustrates a state in a defrosting operation in which the branch passage 17 is kept in a fully open state by the fully opening hole 18b.

[0044]

The second evaporator 19 is disposed downstream of the throttling mechanism 18 with respect to the flow of refrigerant. This second evaporator 19 is

installed in, for example, a refrigerator (not shown) mounted in a vehicle, and functions to cool the interior of the refrigerator. The refrigerant cycle device is so designed that the air in the refrigerator is blown to the second evaporator 19 by an electric blower (second blower) 20.

5 [0045]

This embodiment is so constructed that the electromagnetic pressure controller 12a of the variable displacement compressor 12, the first and second blowers 16, 20, the throttling mechanism 18, and the like are electrically controlled by a control signal from an electric control unit (hereafter, abbreviated as "ECU") 21. A temperature sensor 22 is disposed in a predetermined position in proximity to the second evaporator 19, and the temperature of air in proximity to the second evaporator 19 is detected by this temperature sensor 22. Detection signals from this temperature sensor 22 are inputted to the ECU 21.

[0046]

15 Description will be given to the operation of this embodiment constructed as mentioned above. When the compressor 12 is driven by the vehicle engine, refrigerant is compressed and brought into a high temperature, high pressure state by the compressor 12. The refrigerant flows into the radiator 13, and cooled by outside air and condensed. The high-pressure liquid refrigerant flowing out of the radiator 13 is divided into a flow running through the refrigerant circulation path 11 and a flow running through the branch passage 17.

[0047]

25 In the normal operation (when the second evaporator 19 need not be defrosted), the throttle mechanism 18 in the branch passage 17 is brought into a normal state, illustrated in FIG. 2(a), by a control signal from the ECU 21. The throttle hole 18a is positioned in the branch passage 17. For this reason, the throttle hole 18a functions as a fixed throttle, and thus the refrigerant passed through the branch passage 17 is reduced in pressure by the throttling mechanism 18 and brought into a low pressure state.

30 [0048]

This low-pressure refrigerant absorbs heat from the air in the refrigerator, blown by the second blower 20, in the second evaporator 19, and is evaporated.

Thus, the second evaporator 19 functions to cool the interior of the refrigerator.

[0049]

The flow rate of refrigerant that passes through the first branch passage 17 and flows into the second evaporator 19 can be adjusted by the opening of the throttle hole 18a in the throttling mechanism 18. The cooling capacity of the second evaporator 19 for cooling the space to be cooled (basically, the space in the refrigerator) can be adjusted by controlling the number of revolutions (the quantity of air blown) of the second blower 20 by the ECU 21.

[0050]

The vapor phase refrigerant that flows out of the second evaporator 19 is sucked into the suction port 14c in the ejector 14. The flow of refrigerant running through the refrigerant circulation path 11 goes into the ejector 14, and depressurized and expanded by the nozzle portion 14a. Therefore, the pressure energy of refrigerant is converted into velocity energy through the nozzle portion 14a, and the refrigerant is accelerated and jetted from the nozzle jet hole. At this time, the pressure drops in proximity to the nozzle portion, thereby the vapor phase refrigerant evaporated at the second evaporator 19 is sucked in through the suction port 14c.

[0051]

The refrigerant jetted from the nozzle portion 14a and the refrigerant sucked through the suction port 14c are mixed together downstream of the nozzle portion 14a, and flow into the diffuser portion 14b. In this diffuser portion 14b, the velocity (expansion) energy of refrigerant is converted into pressure energy by increase in the area of the passage. Therefore, the pressure of refrigerant is increased in the diffuser portion 14b. The refrigerant that flows out of the diffuser portion 14b of the ejector 14 flows into the first evaporator 15.

[0052]

In the first evaporator 15, the refrigerant absorbs heat from the air-conditioning air blown into the vehicle compartment and is evaporated. The evaporated vapor phase refrigerant is sucked into the compressor 12 and compressed there, and is circulated through the refrigerant circulation path 11 again. The ECU 21 can control the refrigerant discharge capacity of the compressor 12 by

controlling the displacement of the compressor 12.

[0053]

Thus, the quantity of refrigerant flowing to the first evaporator 15 is adjusted, and further the number of revolutions (the quantity of blown air) of the first blower 26 is controlled. Consequently, the cooling capacity of the first evaporator 15 for cooling the space to be cooled, specifically, the vehicle compartment can be controlled.

[0054]

The refrigerant evaporating pressure of the first evaporator 15 is a pressure increased through the diffuser portion 14b, and the outlet of the second evaporator 19 is connected to the suction port 14c in the ejector 14. Therefore, the lowest pressure obtained immediately after depressurization at the nozzle portion 14a can be exerted on the second evaporator 19.

[0055]

Thus, the refrigerant evaporating pressure (refrigerant evaporating temperature) of the second evaporator 19 can be made lower than the refrigerant evaporating pressure (refrigerant evaporating temperature) of the first evaporator 15. Therefore, cooling capacity in a relatively high temperature range, suitable for cooling the interior of the vehicle compartment, can be obtained by the first evaporator 15. At the same time, cooling capacity in a relatively low temperature range, suitable for cooling the interior of the refrigerator, can be obtained by the second evaporator 19.

[0056]

There are cases where the second evaporator 19 is operated under conditions of the refrigerant evaporating temperature of 0°C or below. This causes a problem of degradation in cooling performance due to frost (frosting) on the second evaporator 19.

[0057]

To cope with this, this embodiment is constructed such that a temperature sensor 22 is disposed in proximity to the second evaporator 19, and based on the temperature detected by this temperature sensor 22, it is determined by the ECU 21 whether the second evaporator 19 is frosted or not. Thus, the second

evaporator 19 is automatically defrosted.

[0058]

More specific description will be given. When the temperature of air in proximity to the second evaporator 19, detected by the temperature sensor 22, falls to a preset frost determination temperature T_a or below, the ECU 21 determines that the second evaporator 19 is frosted. In this case, the ECU 21 outputs a control signal to the electric actuator 18d for the throttling mechanism 18 provided with the fully opening function. The electric actuator 18d shifts the movable plate member 18c from the normal position illustrated in FIG. 2(a) to the defrosting position illustrated in FIG. 2(b).

[0059]

Thus, the fully opening hole 18b in the movable plate member 18c is superposed on the entire sectional area of the branch passage 17, and the branch passage 17 is brought into a fully open state. As a result, the high-temperature, high-pressure liquid refrigerant at the outlet of the radiator 13 can be directly led to the second evaporator 19 through the branch passage 17. Thus, the frost that has formed on the surface of the second evaporator 19 can be melted, and the operation of defrosting the second evaporator 19 can be performed by a very simple construction.

[0060]

Execution of this defrosting operation raises the temperature of air in proximity to the second evaporator 19. When this temperature rises to a defrosting termination temperature T_b , higher than the frost determination temperature T_a by a predetermined temperature α ($T_b = T_a + \alpha$), the ECU 21 determines that defrosting is completed. In this case, the ECU 21 outputs a control signal for return to the normal position to the electric actuator 18d for the throttling mechanism 18 provided with the fully opening function.

[0061]

Thus, the electric actuator 18d returns the movable plate member 18c from the defrosting position illustrated in FIG. 2(b) to the normal position illustrated in FIG. 2(a). For this reason, the throttling mechanism 18 functions as a fixed throttle through the throttle hole 18a, and thus the second evaporator 19 is also returned to

a state in which it exerts the cooling operation.

[0062]

(Second Embodiment)

FIG. 3 illustrates a second embodiment, and in the following description, the same members as in the first embodiment will be indicated with the same numerals and the description thereof will be omitted. In the second embodiment, a bypass passage 23 is formed which directly connects the passage on the discharge side of the compressor 12 and the inlet portion of the second evaporator 19. A shut mechanism 24 is provided in this bypass passage 23. Specifically, this shut mechanism 24 can be constructed of a normally closed electromagnetic valve that is opened only when energized.

[0063]

In the second embodiment, the shut mechanism 24 is kept in a shut state by a control signal from the ECU 21 in the normal operation (when the second evaporator 19 need not be defrosted). For this reason, in the normal operation, refrigerant is not passed through the bypass passage 23, and thus the same refrigerant cycle operation as in the first embodiment is performed by the operation of the compressor 12. As a result, the cooling capacity in a relatively high temperature range, suitable for cooling the interior of the vehicle compartment, can be obtained by the first evaporator 15. At the same time, the cooling capacity in a relatively low temperature range, suitable for cooling the interior of the refrigerator, can be obtained by the second evaporator 19.

[0064]

When the temperature of air in proximity to the second evaporator 19, detected by the temperature sensor 22, falls to a preset frost determination temperature T_a or below, the ECU 21 determines that the second evaporator 19 is frosted. In this case, the ECU 21 outputs a control signal to the shut mechanism 24 to open the shut mechanism 24.

[0065]

As a result, the high-temperature, high-pressure vapor phase refrigerant on the discharge side of the compressor 12 passes through the bypass passage 23 and flows into the second evaporator 19. Therefore, the frost that has formed on

the surface of the second evaporator 19 can be melted, and the operation of defrosting the second evaporator 19 can be performed by a very simple construction. The completion of defrosting can be determined by the same procedure as in the first embodiment, and the shut mechanism 24 is returned to a shut state.

[0066]

In the second embodiment, a throttling mechanism 180 in the branch passage 17 need not be provided with a fully opening function. Therefore, it can be constructed using an ordinary fixed throttle or variable throttle.

[0067]

(Third Embodiment)

FIG. 4 illustrates the third embodiment, which is a modification to the first embodiment. In the third embodiment, a second branch passage 25 is added to the construction of the first embodiment. The second branch passage 25 connects the portion of the branch passage 17 on the upstream side of the throttling mechanism 18 provided with the fully opening function and a point between the first evaporator 15 and the compressor 12.

[0068]

In the second branch passage 25, there is provided with a throttling mechanism 26 that reduces the pressure of refrigerant and a third evaporator 27 positioned downstream from the throttling mechanism 26 with respect to the flow of refrigerant. Since the throttling mechanism 26 need not be provided with a fully opening function, it can be constructed using an ordinary fixed throttle or variable throttle. Air in the space to be cooled is blown to the third evaporator 27 by an electric blower (third blower) 28. The operation of this third blower 28 is also controlled by the ECU 21.

In the third embodiment, the downstream side of the third evaporator 27 is hooked up to the downstream side of the first evaporator 15, and then connected to the suction side of the compressor 12. Therefore, the refrigerant evaporating pressures of the first and third evaporators 15, 27 are substantially equal to the inlet pressure of the compressor 12. Accordingly, the refrigerant evaporating temperatures of the first and third evaporators 15, 27 are identical with each other,

and thus the first and third evaporators 15, 27 exert the cooling operation in the same temperature range, similarly to the above first embodiment.

[0069]

Also in the third embodiment, the refrigerant evaporating temperature of the second evaporator 19 is lower than the refrigerant evaporating temperature of the first and third evaporators 15, 27. However, the second evaporator 19 can be defrosted as in the first embodiment by bringing the throttling mechanism 18 provided with the fully opening function into a fully open state.

[0070]

A concrete example of the spaces to be cooled by the first to third evaporators 15, 19, 27 in the third embodiment can be shown in the following case: the front seat area in a vehicle compartment is cooled with the first evaporator 15; the rear seat area in the vehicle compartment is cooled with the third evaporator 27; and the interior of a refrigerator is cooled with the second evaporator 19.

[0071]

(Fourth Embodiment)

FIG. 5 illustrates a fourth embodiment, which is a modification to the second embodiment (FIG. 3). More specific description will be given. In the fourth embodiment, on the construction of the second embodiment, a second branch passage 25 is added so as to connect a portion of the branch passage 17 located upstream of the throttling mechanism 180 and a portion between the first evaporator 15 and the compressor 12. The throttling mechanism 26 and the third evaporator 27 are disposed in the second branch passage 25. The throttling mechanism 26 and the third evaporator 27 are identical with those in the third embodiment.

[0072]

In the fourth embodiment constructed as mentioned above, the second evaporator 19 can be defrosted by using the bypass passage 23 and the shut mechanism 24 as in the second embodiment. Further, the cooling capacity of the third evaporator 27 can be obtained as in the third embodiment.

[0073]

(Fifth Embodiment)

FIG. 6 illustrates the fifth embodiment, which is a modification to the first embodiment. More specific description will be given. In the fifth embodiment, a dedicated throttling mechanism 30 is added to the area located upstream of the first evaporator 15, so that the ejector 14 is disposed in parallel with the throttling mechanism 30. Various items can be used for the throttling mechanism 30. For example, a temperature expansion valve is suitable which controls the degree of superheat of refrigerant at the outlet of the first evaporator 15 to a predetermined value.

[0074]

The throttling mechanism 18 provided with the fully opening function is disposed upstream of the second evaporator 19. When the second evaporator 19 requires defrosting, the throttling mechanism 18 is fully opened to perform the operation of defrosting the second evaporator 19. This is the same as in the first embodiment.

[0075]

Description will be given to the features of the fifth embodiment in comparison with the first embodiment. In any of the first to fourth embodiments, the ejector 14 and the first evaporator 15 are connected in series with each other. Therefore, the ejector 14 carries out the function of regulating the refrigerant flow rate of the first evaporator 15, and further carries out the function of pump to produce a refrigerant pressure difference between the first evaporator 15 and the second evaporator 19.

[0076]

In designing the ejector 14, therefore, both the specification requirements for the refrigerant flow-rate regulating function and for the pump function must be met. To ensure the function of regulating the refrigerant flow rate of the first evaporator 15, the design of the ejector inevitably depends on the first evaporator 15. As a result, a problem arises. It is difficult to operate the ejector cycle with high accuracy.

[0077]

To cope with this, the fifth embodiment takes such a measure as illustrated in FIG. 6. The dedicated throttling mechanism 30 is disposed upstream of the first

evaporator 15 so that the ejector 14 need not be in charge of the function of regulating the refrigerant flow rate of the first evaporator 15. For this reason, the ejector 14 can be specialized in the pump function to produce a refrigerant pressure difference between the first evaporator 15 and the second evaporator 19.

5 [0078]

Thus, the shape of the ejector 14 can be optimally designed so that a predetermined pressure difference is produced between the first and second evaporators 15, 19. In other words, it can be optimally designed so that the flow rate of refrigerant passed through the ejector 14 becomes a predetermined flow rate. As a result, the ejector cycle can be operated with high efficiency even if cycle operating conditions (number of compressor revolutions, ambient temperature, temperature of space to be cooled, etc.) fluctuates over a wide range.

[0079]

(Sixth Embodiment)

15 FIG. 7 illustrates a sixth embodiment, which is a modification to the second embodiment (FIG. 3). Like the second embodiment, the sixth embodiment has a cycle configuration including the bypass passage 23 and the shut mechanism 24 for the operation of defrosting the second evaporator 19. Further, a dedicated throttling mechanism 30 is added to the area located upstream of the first evaporator 15, and the ejector 14 is connected in parallel with this throttling mechanism 30. This construction in which the throttling mechanism 30 and the ejector 14 are in parallel connection is the same as in the fifth embodiment (FIG. 6).

20 [0080]

Therefore, the sixth embodiment can produce the function and effect that would be produced by a combination of the second embodiment and the fifth embodiment.

25 [0081]

(Seventh Embodiment)

30 FIG. 8 illustrates the seventh embodiment, which is a modification to the third embodiment (FIG. 4). More specific description will be given. Like the third embodiment, the seventh embodiment has a cycle configuration in which a throttling mechanism 18 provided with a fully opening function for defrosting

operation is disposed upstream of the second evaporator 19; at the same time, the throttling mechanism 26 and the third evaporator 27 are provided. Further, a dedicated throttling mechanism 30 is added to the area located upstream of the first evaporator 15, and the ejector 14 is connected in parallel with this throttling mechanism 30. This parallel connection of the ejector 14 is the same as in the fifth embodiment (FIG. 6).

[0082]

Therefore, the seventh embodiment can produce the function and effect that would be produced by a combination of the third embodiment and the fifth embodiment.

[0083]

(Eighth Embodiment)

FIG. 9 illustrates the eighth embodiment, which is a modification to the fourth embodiment (FIG. 5). More specific description will be given. Like the fourth embodiment, the eighth embodiment has a cycle configuration in which the bypass passage 23 and the shut mechanism 24 for the operation of defrosting the second evaporator 19 are provided; at the same time, the throttling mechanism 26 and the third evaporator 27 are provided. Further, a dedicated throttling mechanism 30 is added to the area located upstream of the first evaporator 15, and the ejector 14 is connected in parallel with this throttling mechanism 30. This parallel connection of the ejector 14 is the same as in the fifth embodiment (FIG. 6).

[0084]

Therefore, the eighth embodiment can produce the function and effect that would be produced by a combination of the fourth embodiment and the fifth embodiment.

[0085]

(Ninth Embodiment)

FIG. 10 illustrates the ninth embodiment, which is a modification to the first embodiment. More specific description will be given. In the ninth embodiment, on the cycle configuration of the first embodiment, a shut mechanism 31 is additionally provided in the portion of the refrigerant circulation path 11 located upstream of the ejector 14. Specifically, this shut mechanism 31 can be

constructed of a normally open electromagnetic valve that is closed only when energized.

[0086]

According to the ninth embodiment, the shut mechanism 31 is kept in a fully open state by a control signal from the ECU 21 in the normal operation (when the second evaporator 19 need not be defrosted). Therefore, the ejector cycle 10 performs the same operation as in the first embodiment.

[0087]

When it is determined by the ECU 21 based on the temperature of air in proximity to the second evaporator 19, detected by the temperature sensor 22, that the second evaporator 19 is frosted, the following takes place: the ECU 21 outputs a control signal to the shut mechanism 31 to bring the shut mechanism 31 into a shut (fully closed) state. At the same time, the ECU 21 outputs a control signal to the throttling mechanism 18 provided with the fully opening function to bring the throttling mechanism 18 into a fully open state.

[0088]

During this defrosting operation, the refrigerant circulation path 11 is brought into a shut state by the shut mechanism 31. Therefore, all of the high-temperature, high-pressure refrigerant at the outlet of the radiator 13 passes through the throttling mechanism 18 and flows into the second evaporator 19. As a result, the defrosting capability can be enhanced as compared with the first embodiment, and defrosting of the second evaporator 19 can be completed in a short time.

[0089]

(10th Embodiment)

FIG. 11 illustrates the 10th embodiment, which is a modification to the second embodiment (FIG. 3). More specific description will be given. In the 10th embodiment, on the cycle configuration of the second embodiment, a shut mechanism 31 is additionally provided in the portion of the refrigerant circulation path 11 located upstream of the ejector 14. Specifically, this shut mechanism 31 can be constructed of a normally open electromagnetic valve that is closed only when energized.

[0090]

According to the 10th embodiment, the shut mechanism 31 is kept in a fully open state by a control signal from the ECU 21 in the normal operation (when the second evaporator 19 need not be defrosted). Therefore, the ejector cycle 10 performs the same operation as in the second embodiment.

5 [0091]

When it is determined by the ECU 21 based on the temperature of air in proximity to the second evaporator 19, detected by the temperature sensor 22, that the second evaporator 19 is frosted, the following takes place: the ECU 21 outputs a control signal to the shut mechanism 31 to bring the shut mechanism 31 into a shut (fully closed) state. At the same time, the ECU 21 outputs a control signal to the shut mechanism 24 in the bypass passage 23 to bring the shut mechanism 24 into a fully open state.

[0092]

During this defrosting operation, the refrigerant circulation path 11 is brought into a shut state by the shut mechanism 31. Therefore, the quantity of high-temperature, high-pressure vapor phase refrigerant on the discharge side of the compressor 12, which passes through the bypass passage 23 and flows into the second evaporator 19, is increased. As a result, the defrosting capability can be enhanced as compared with the second embodiment, and defrosting of the second evaporator 19 can be completed in a short time.

[0093]

(11th Embodiment)

FIG. 12 illustrates an 11th embodiment, which is a modification to the 10th embodiment (FIG. 11). More specific description will be given. In the 11th embodiment, a shut mechanism 32 corresponding to the shut mechanism 31 in the 10th embodiment is provided upstream of the radiator 13. Specifically, this shut mechanism 32 can also be constructed of a normally open electromagnetic valve as the shut mechanism 31 in the ninth and 10th embodiments.

[0094]

In the 11th embodiment, when it is determined by the ECU 21 based on the temperature of air in proximity to the second evaporator 19 that the second evaporator 19 is frosted, the ECU 21 outputs a control signal to the shut

mechanism 32 to bring the shut mechanism 32 into a shut (fully closed) state. At the same time, the ECU 21 outputs a control signal to the shut mechanism 24 in the bypass passage 23 to bring the shut mechanism 24 into a fully open state.

[0095]

5 During this defrosting operation, the passage located upstream of the radiator 13 is brought into a shut state by the shut mechanism 32. Therefore, all of the high-temperature, high-pressure vapor phase refrigerant on the discharge side of the compressor 12 passes through the bypass passage 23 and flows into the second evaporator 19. Thus, the defrosting capability can be further enhanced
10 than in the 10th embodiment.

[0096]

In the 11th embodiment, the two shut mechanisms 24, 32 may be constructed of one passage switching mechanism of three-way valve type.

[0097]

15 (12th Embodiment)

FIG. 13 illustrates the 12th embodiment, which is a modification to the first embodiment. Specifically, the 12th embodiment uses a throttling mechanism 180 constructed of an ordinary fixed throttle or variable throttle not provided with a fully opening function in place of the throttling mechanism provided with the fully opening
20 function in the first embodiment.

[0098]

A bypass passage 33 is provided in parallel with this throttling mechanism 180, and a shut mechanism 34 is provided in the bypass passage 33. Specifically, this shut mechanism 34 can be constructed of a normally closed electromagnetic
25 valve that is opened only when energized.

[0099]

According to the 12th embodiment, the shut mechanism 34 is kept in a shut (fully closed) state by a control signal from the ECU 21 in the normal operation (when the second evaporator 19 need not be defrosted). Therefore, the quantity
30 of refrigerant flowing into the second evaporator 19 is regulated by the throttling mechanism 180.

[0100]

When the second evaporator 19 is determined to be frosted (in the defrosting operation), the shut mechanism 34 is switched to transition to a fully open state by a control signal from the ECU 21. Thus, the high-temperature, high-pressure liquid refrigerant at the outlet of the radiator 13 passes through the bypass passage 33 and flows into the second evaporator 19 in the defrosting operation. As a result, the second evaporator 19 can be defrosted.

[0101]

Up to this point, the 12th embodiment has been described as a modification to the first embodiment. The idea of the 12th embodiment can be similarly used in other embodiments (third, fifth, seventh, and ninth embodiments) including the throttling mechanism 18 provided with the fully opening function than the first embodiment. The defrosting operation can be performed by providing the ordinary throttling mechanism 180 not provided with the fully opening function, the bypass passage 33 and the shut mechanism 34, in place of the throttling mechanism 18 provided with the fully opening function.

[0102]

(13th Embodiment)

Any of the first to 12th embodiments is so constructed that the branch passage 17, branched at the outlet side of the radiator 13 and connected to the suction port 14c of the ejector 14, is formed and the throttling mechanisms 18, 180 and the second evaporator 19 are disposed in this branch passage 17. In the 13th embodiment, the second evaporator 19 is disposed differently from that in each of the above embodiments.

[0103]

More specific description will be given. In the 13th embodiment, a vapor-liquid separator 35 is disposed between the refrigerant outflow side of the first evaporator 15 and the suction side of the compressor 12, as illustrated in FIG. 14. The vapor-liquid separator 35 separates the refrigerant at the outlet of the first evaporator 15 into vapor and liquid, and stores the liquid phase refrigerant therein. The 13th embodiment is so constructed that the vapor phase refrigerant separated by the vapor-liquid separator 35 is led out to the suction side of the compressor 12, and the liquid phase refrigerant separated by the vapor-liquid separator 35 is led

out to a branch passage 36.

[0104]

This branch passage 36 is a passage that connects the liquid refrigerant outlet in proximity to the bottom of the vapor-liquid separator 35 and the suction port 14c of the ejector 14. The throttling mechanism 180 is provided on the upstream side of the branch passage 36, and the second evaporator 19 is disposed downstream of the throttling mechanism 180. The throttling mechanism 180 is constructed of an ordinary fixed throttle or variable throttle not provided with a fully opening function.

[0105]

The downstream end of a bypass passage 23 including the shut mechanism 24 is connected to the branch passage 36 between the throttling mechanism 180 and the second evaporator 19.

[0106]

Also in the cycle configuration of the 13th embodiment, the refrigerant evaporating pressure (refrigerant evaporating temperature) of the second evaporator 19 is lower than the refrigerant evaporating pressure (refrigerant evaporating temperature) of the first evaporator 15. Therefore, the cooling operation in a high temperature range can be performed by the first evaporator 15, and the cooling operation in a low temperature range can be performed by the second evaporator 19.

[0107]

When the second evaporator 19 is determined to be frosted, the shut mechanism 24 in the bypass passage 23 is opened by a control signal from the ECU 21. As a result, the high-temperature, high-pressure vapor phase refrigerant on the discharge side of the compressor 12 passes through the bypass passage 23 and flows into the second evaporator 19 through the bypass passage 23. Therefore, the second evaporator 19 can be defrosted.

[0108]

(Other Embodiments)

The present invention is not limited to the above-described embodiments, and various modifications can be made thereto, as described below.

[0109]

(1) In the above-described embodiments, the temperature of air in proximity to the second evaporator 19 is detected by using the temperature sensor 22, and defrosting operation is automatically performed. This is just an example. Various modifications can be made to automatic control on defrosting operation. Some examples will be taken. Instead of the temperature of air in proximity to the second evaporator 19, the surface temperature of the second evaporator 19 may be detected by using the temperature sensor 22 to automatically control defrosting operation.

[0110]

A refrigerant temperature sensor for detecting the temperature of refrigerant may be provided in a refrigerant passage in proximity to the second evaporator 19, and defrosting operation may be automatically controlled based on the temperature of refrigerant in proximity to the second evaporator 19. There is correlation between the temperature of refrigerant in proximity to the second evaporator 19 and the pressure of the refrigerant. Therefore, a refrigerant pressure sensor for detecting the pressure of refrigerant in proximity to the second evaporator 19 may be provided, and defrosting operation may be automatically controlled based on the pressure of refrigerant in proximity to the second evaporator 19.

[0111]

The temperature sensor 22 and refrigerant pressure sensor as mentioned above may be removed. Instead, defrosting operation may be automatically performed only for a predetermined time at predetermined time intervals according to the timer function of the ECU 21 after the cycle is started.

[0112]

(2) As the throttling mechanism 18 provided with the fully opening function, FIG. 2 shows one which is so constructed that: the movable plate member 18c has the throttle hole 18a constituting a fixed throttle and the fully opening hole 18b for fully opening the branch passage 17 formed therein; and the movable plate member 18c is driven by the electric actuator 18d. Alternatively, an electric expansion valve, in which valve element opening is continuously varied by an electric actuator, such as a servo motor, may be used for the throttling mechanism

18 provided with the fully opening function. Thus, the electric expansion valve is fully opened in the defrosting of the second evaporator 49.

[0113]

(3) The description of the first embodiment and the like takes an example where the present invention is applied to an air conditioner and a refrigerator for a vehicle. However, the first evaporator 15 in which the refrigerant evaporating temperature is higher and the second evaporator 19 in which the refrigerant evaporating temperature is lower may be both used for cooling different areas in the vehicle compartment (e.g., vehicle front seat area and vehicle rear seat area)

[0114]

Furthermore, the first evaporator 15 in which the refrigerant evaporating temperature is higher and the second evaporator 19 in which the refrigerant evaporating temperature is lower may be both used for cooling an interior of a refrigerator. That is, the present invention may be so constructed that: the cold room of a refrigerator is cooled with the first evaporator 15 in which the refrigerant evaporating temperature is higher; and the freezing room in the refrigerator is cooled with the second evaporator 19 in which the refrigerant evaporating temperature is lower.

[0115]

(4) Though not specified in the above description of the embodiments, any kind of refrigerant can be used as long as it is applicable to a vapor compression refrigerant cycle. Such refrigerants include fluorocarbon refrigerants, HC alternatives for chlorofluorocarbon, and carbon dioxide (CO₂).

[0116]

Chlorofluorocarbon cited here is the generic designation for organic compounds composed of carbon, fluorine, chlorine, and hydrogen, and is widely used as refrigerant. Fluorocarbon refrigerants include HCFC (hydrochlorofluorocarbon) refrigerant, HFC (hydrofluorocarbon) refrigerant, and the like. Since these refrigerants do not destroy the ozone layer, they are called alternatives for chlorofluorocarbon.

[0117]

HC (hydrocarbon) refrigerants refer to refrigerant substances that contain

hydrogen and carbon and occur in nature. HC refrigerants include R600a (isobutane), R290 (propane), and the like.

[0118]

(5) All of the first to 12th embodiments described above are the examples of constructions in which a vapor-liquid separator is not used. However, a liquid receiver that separates refrigerant into vapor and liquid and lets only liquid refrigerant out to the downstream side may be disposed downstream of the radiator 13. The vapor-liquid separator 35 provided in the 13th and following embodiments may be disposed on the suction side of the compressor 12 in the first to 12th embodiments. In this case, the compressor 12 is caused to suck only vapor phase refrigerant.

[0119]

(6) The above-described embodiments are so constructed that: a variable displacement compressor is used as the compressor 12; the displacement of this variable displacement compressor 12 is controlled by the ECU 21; and the refrigerant discharge capacity of the compressor 12 is thereby controlled. However, a fixed displacement compressor may be used as the compressor 12. In this case, the operation of the fixed displacement compressor 12 is on/off-controlled by using an electromagnetic clutch, and the ratio of on-operation to off-operation of the compressor 12 is thereby controlled, so that the refrigerant discharge capacity of the compressor 12 is controlled.

[0120]

When a motor-driven compressor is used as the compressor 12, the refrigerant discharge capacity can be controlled by controlling the number of revolutions of the motor-driven compressor 12.

[0121]

(7) In the above-described embodiments, a variable flow rate ejector may be used as the ejector 14. The variable flow rate ejector is so constructed as to detect the degree of superheat of refrigerant at the outlet of the first evaporator 15 or the like, and adjust the refrigerant passage sectional area of the nozzle 14a, that is, the flow rate of the ejector 14. Thus, the pressure of refrigerant jetted from the nozzle 14a (the flow rate of sucked vapor phase refrigerant) can be controlled.

[Brief Description of Drawings]

[0122]

FIG. 1 is a schematic diagram illustrating an ejector cycle in a first embodiment of the present invention.

5 FIGS. 2(a) and 2(b) are drawings schematically illustrating the operation of the throttling mechanism provided with a fully opening function in the first embodiment.

FIG. 3 is a schematic diagram illustrating an ejector cycle in a second embodiment.

10 FIG. 4 is a schematic diagram illustrating an ejector cycle in a third embodiment.

FIG. 5 is a schematic diagram illustrating an ejector cycle in a fourth embodiment.

15 FIG. 6 is a schematic diagram illustrating an ejector cycle in a fifth embodiment.

FIG. 7 is a schematic diagram illustrating an ejector cycle in a sixth embodiment.

FIG. 8 is a schematic diagram illustrating an ejector cycle in a seventh embodiment.

20 FIG. 9 is a schematic diagram illustrating an ejector cycle in an eighth embodiment.

FIG. 10 is a schematic diagram illustrating an ejector cycle in a ninth embodiment.

25 FIG. 11 is a schematic diagram illustrating an ejector cycle in a 10th embodiment.

FIG. 12 is a schematic diagram illustrating an ejector cycle in an 11th embodiment.

FIG. 13 is a schematic diagram illustrating an ejector cycle in a 12th embodiment.

30 FIG. 14 is a schematic diagram illustrating an ejector cycle in a 13th embodiment.

[EXPLANATION OF SIGN]

[0123]

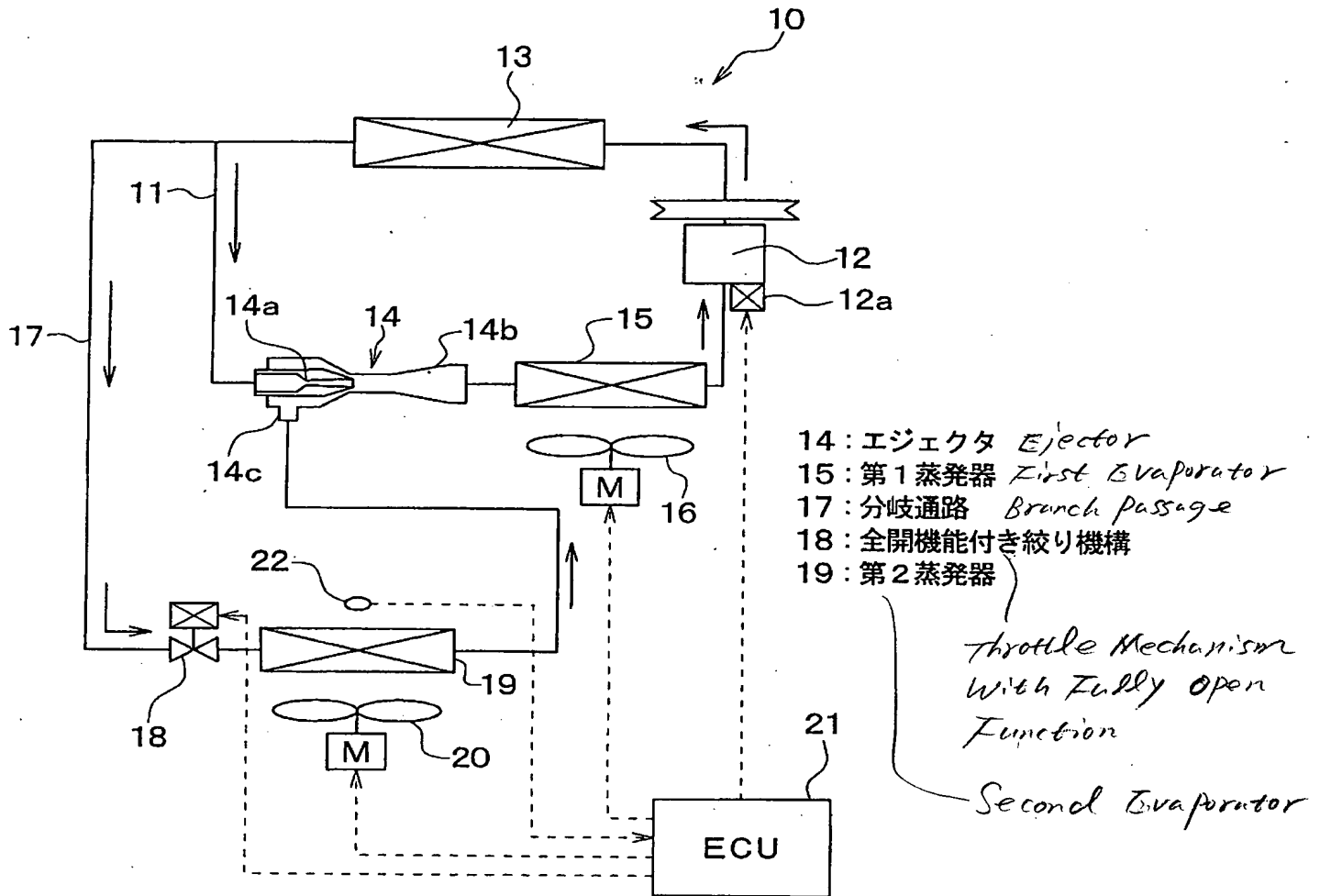
12 . . . a compressor, 13 . . . a radiator, 14 . . . an ejector,
14a . . . a nozzle portion, 14b . . . a diffuser portion (pressure increasing portion),
5 14c . . . a suction port (gas refrigerant suction port), 15 . . . a first evaporator
17, 25, 36 . . . a branch passage,
18, 26, 180 . . . a throttle mechanism (throttle means),
19 . . . a second evaporator, 21 . . . ECU (control means),
23, 33 . . . bypass passage, 24, 31, 32, 34 . . . shut mechanism,
10 27 . . . a third evaporator.

整理番号=IP09361

[Name of Document] 図面 Drawing

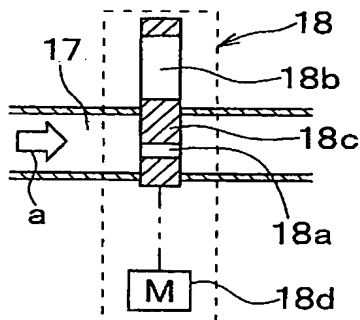
【書類名】 図面 Drawing

【図1】 [Fig. 1]



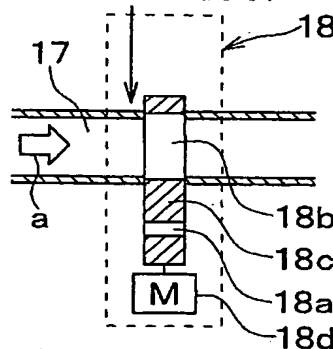
【図2】 [Fig. 2]
In normal (fixed throttle)

(a) 通常時 (固定絞り)

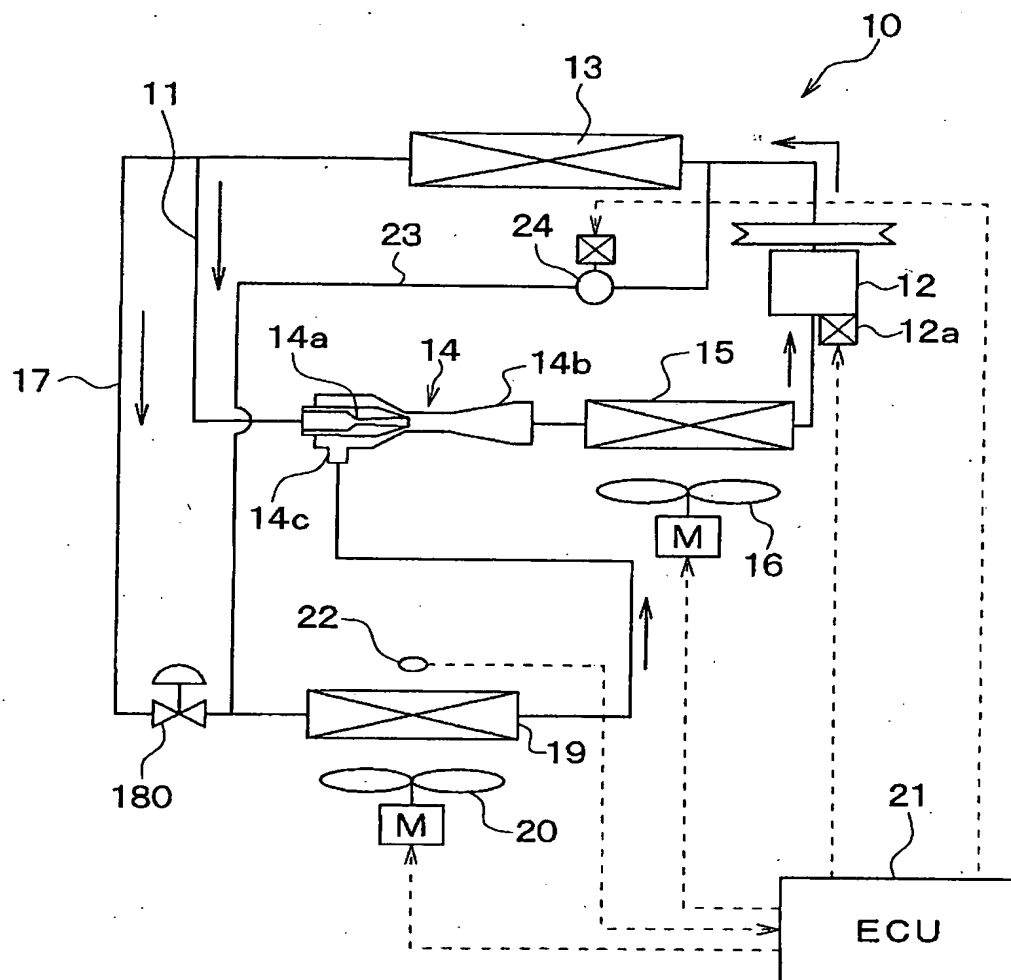


In defrosting (Fully open)

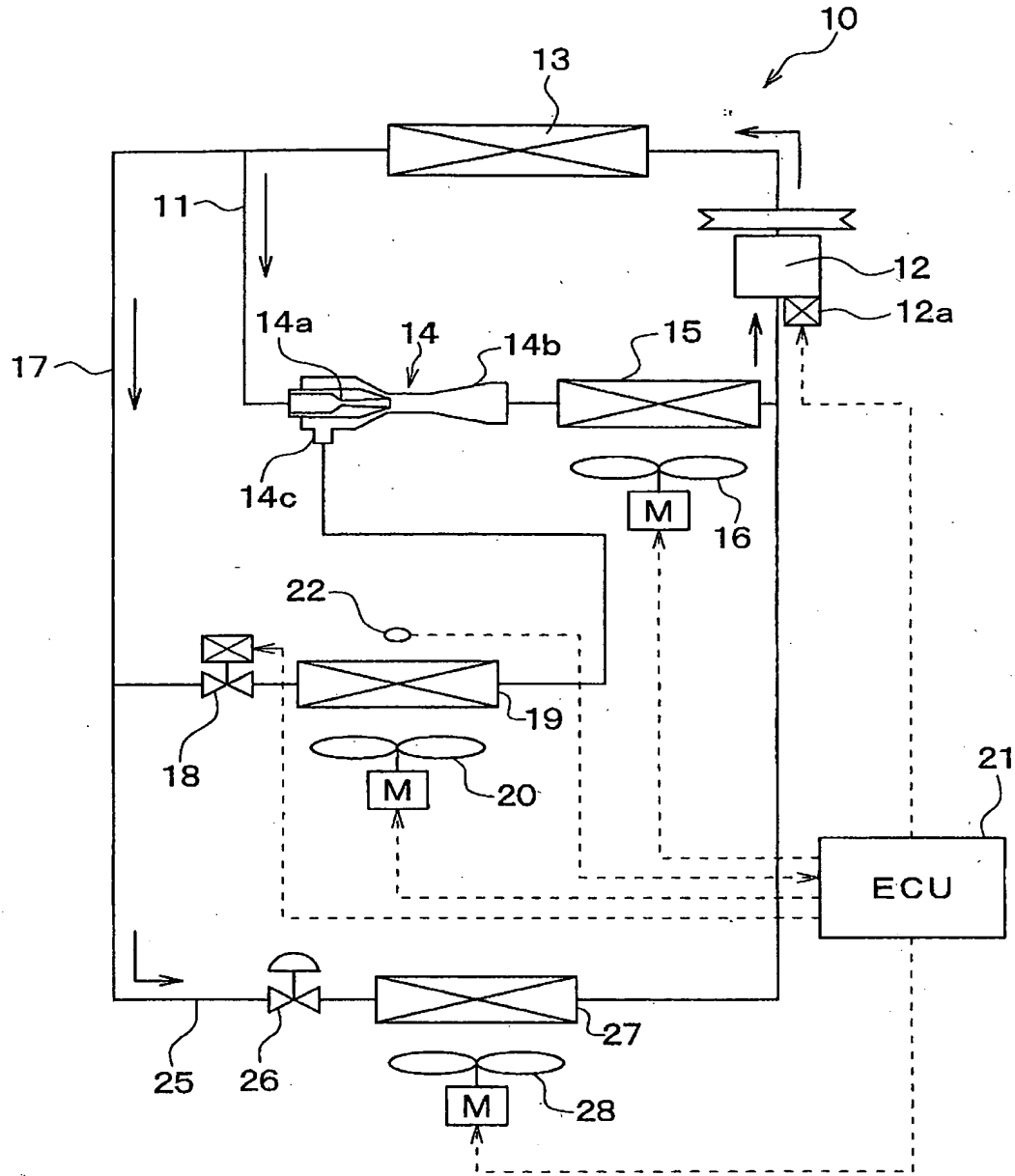
(b) 除霜時 (全開時)



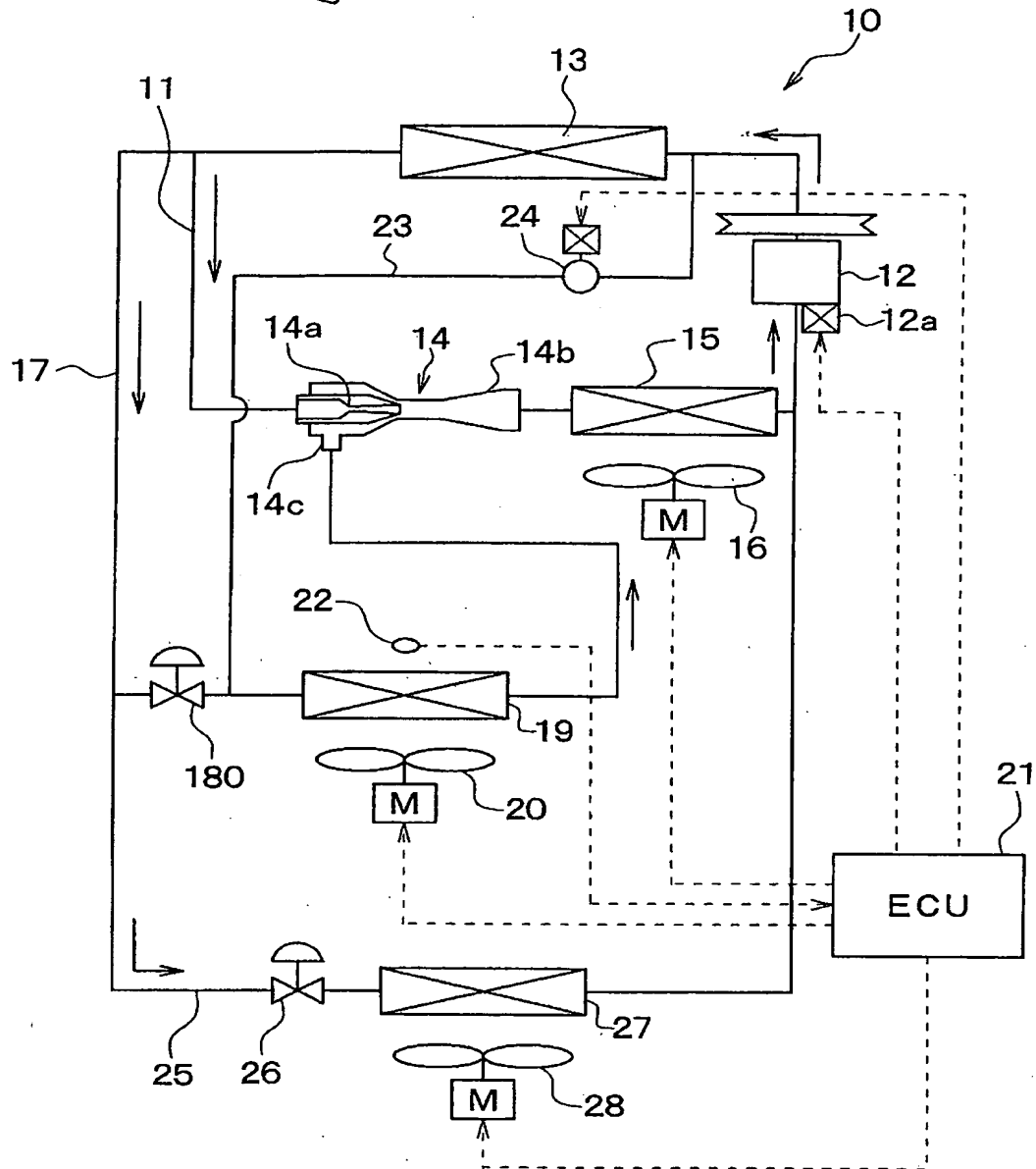
【図 3】 [Fig. 3]



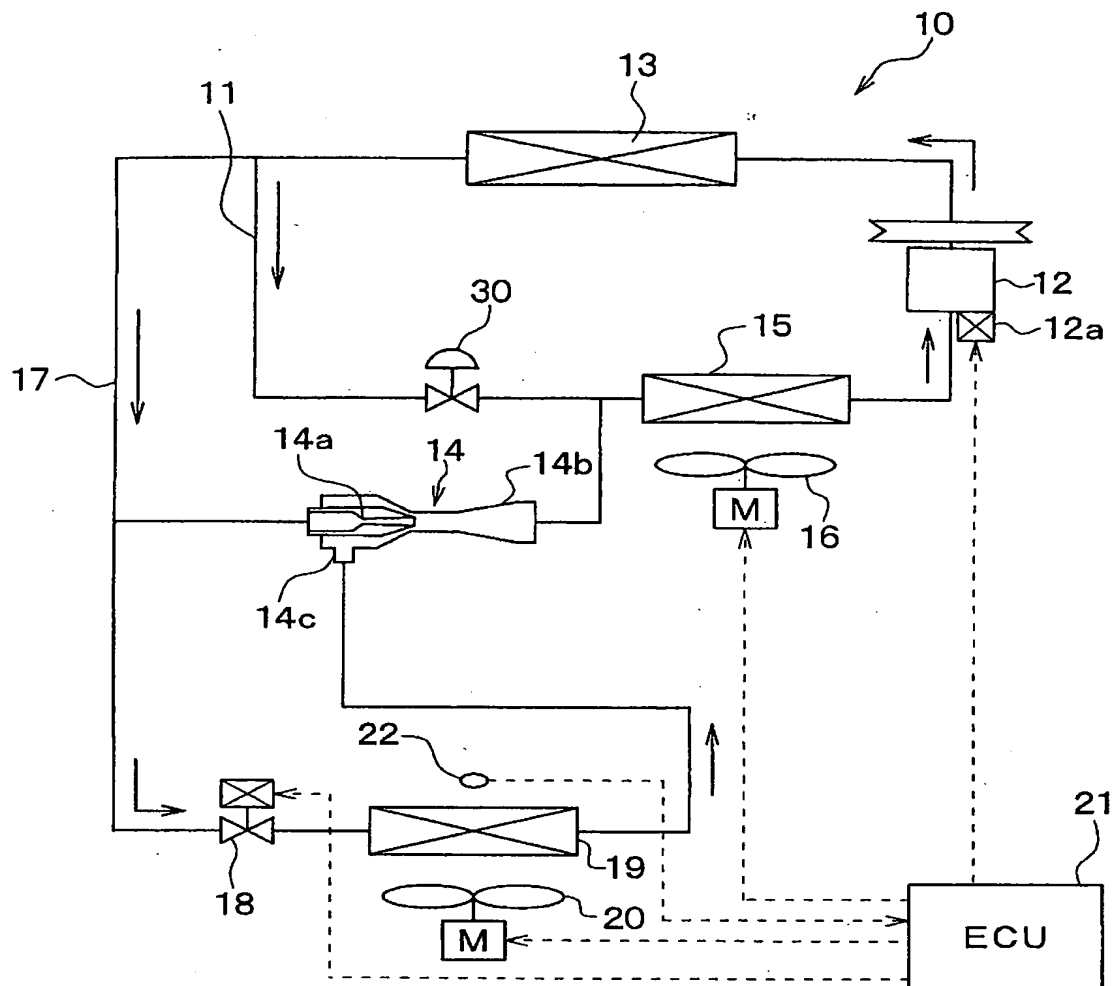
【図4】 [Fig. 4]



【図5】 [Fig.5]



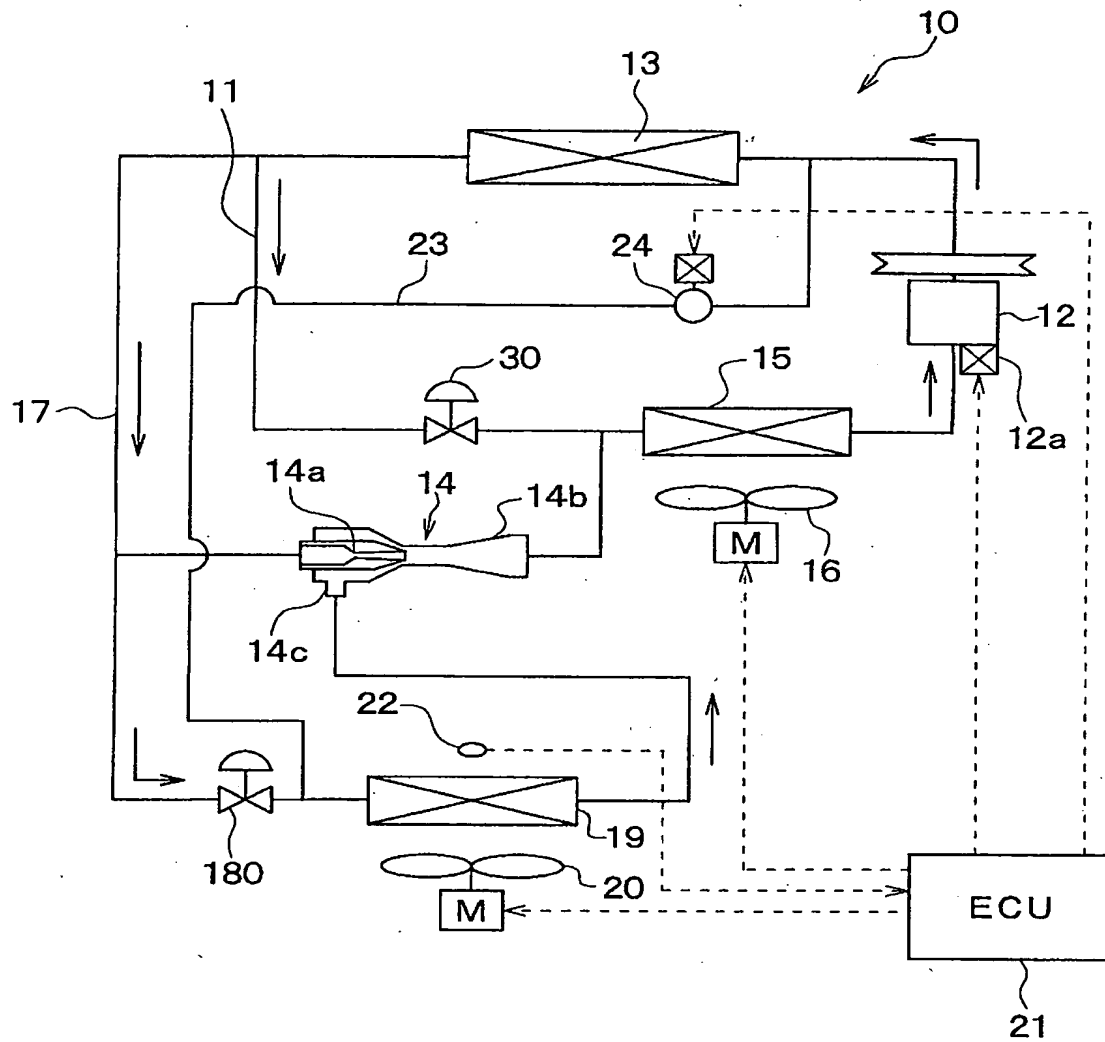
【図 6】 [Fig. 6]



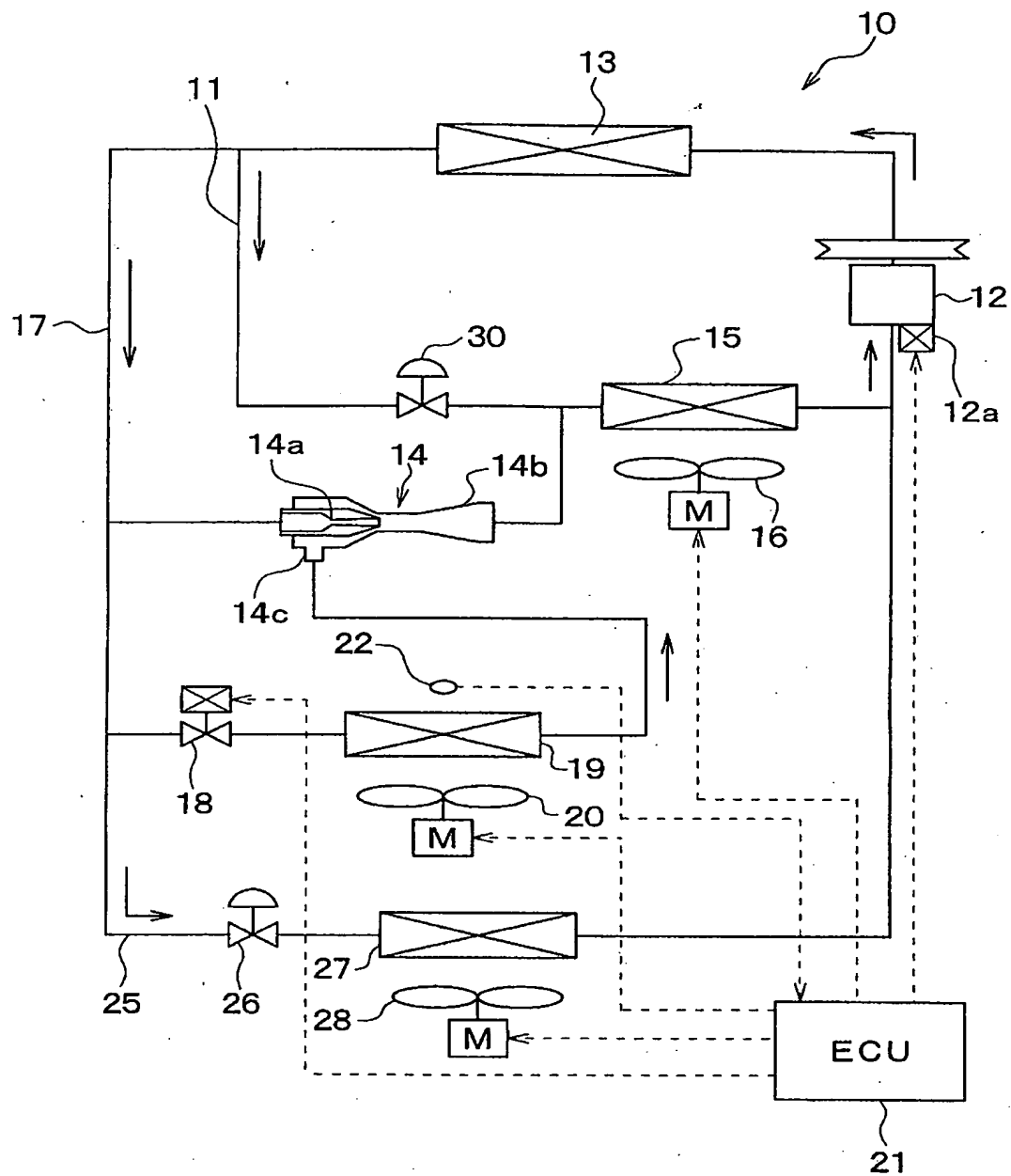
整理番号= I P 0 9 3 6 1

【図 7】

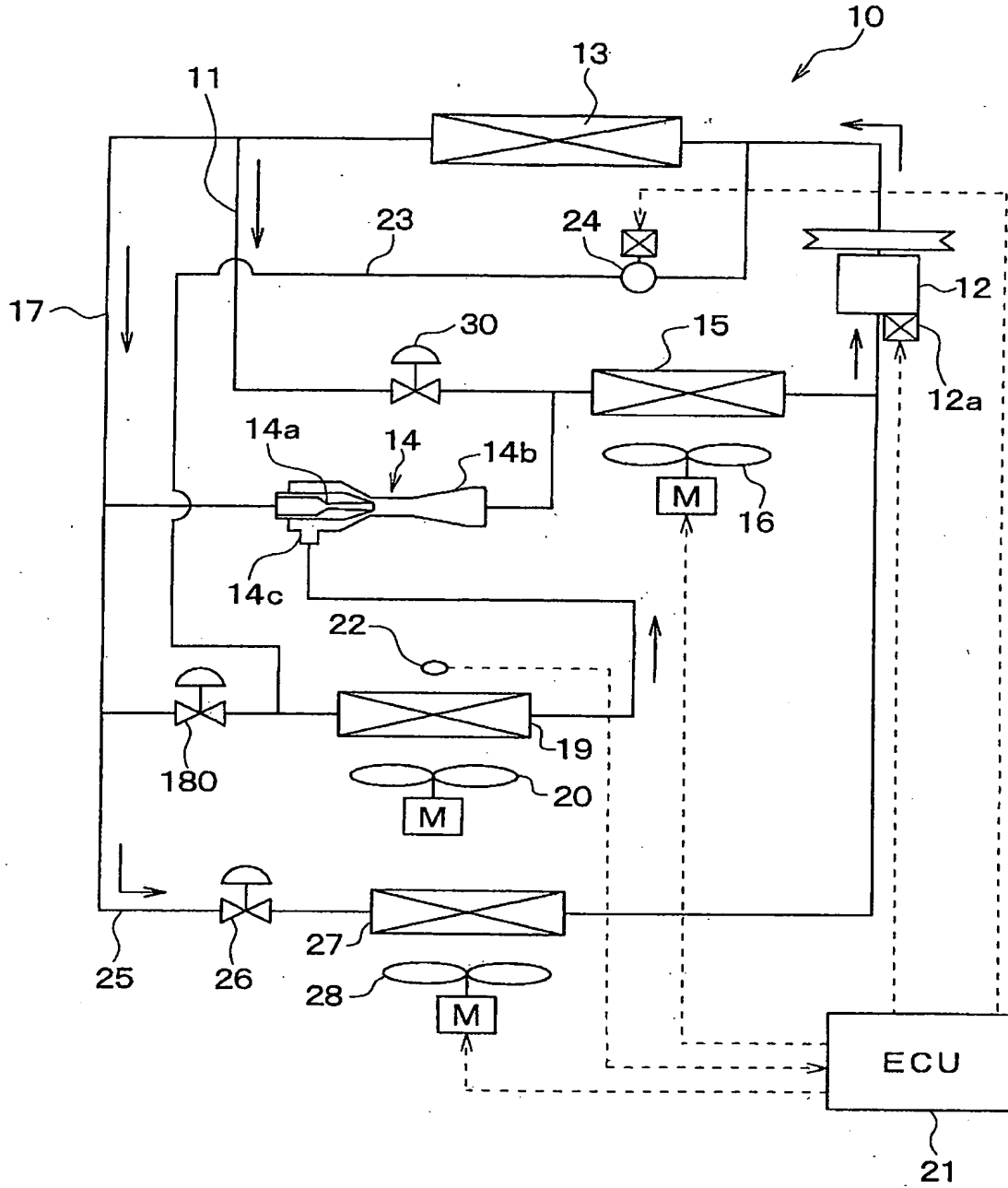
[Fig. 7]



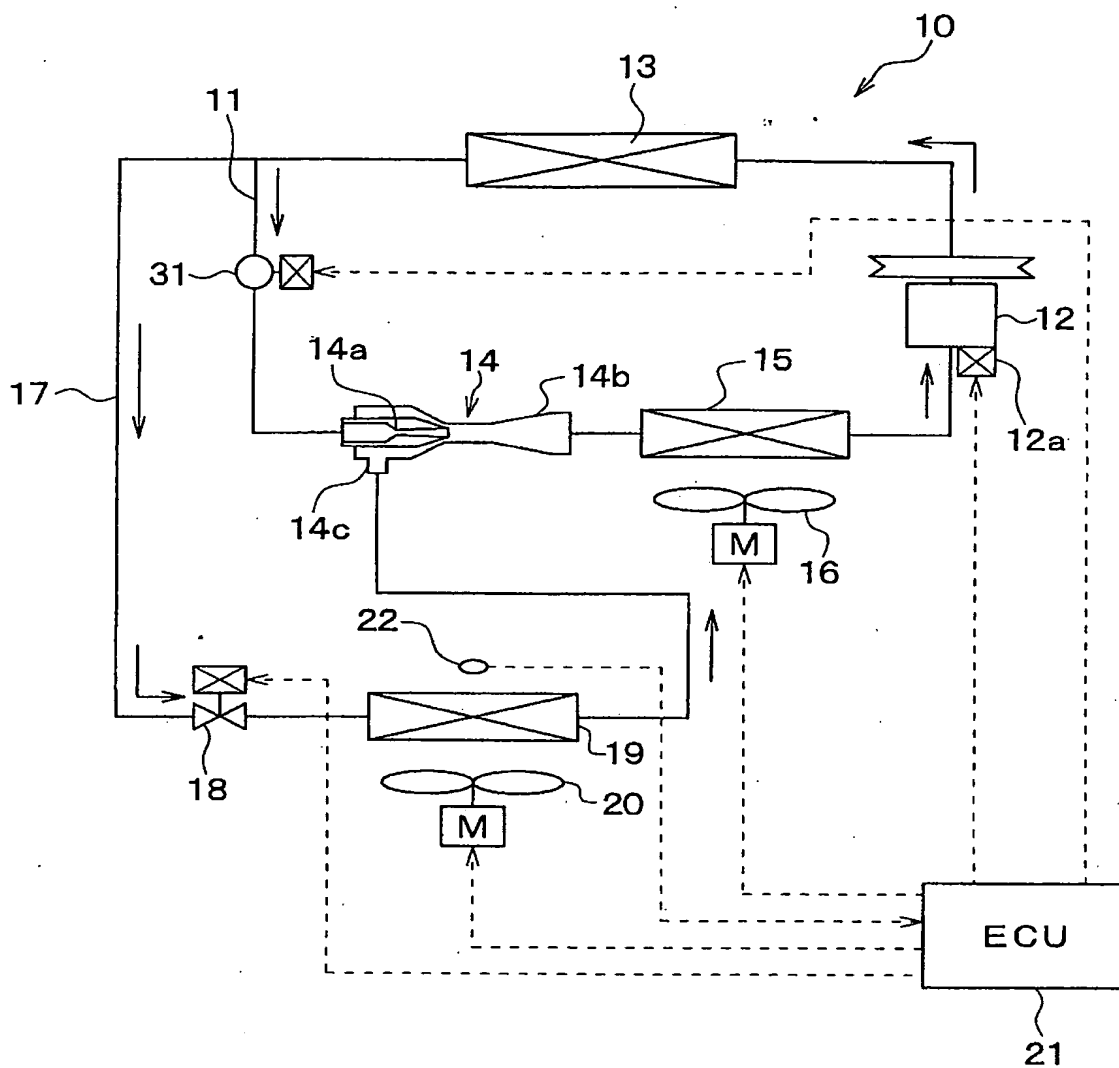
【図 8】 [Fig. 8]



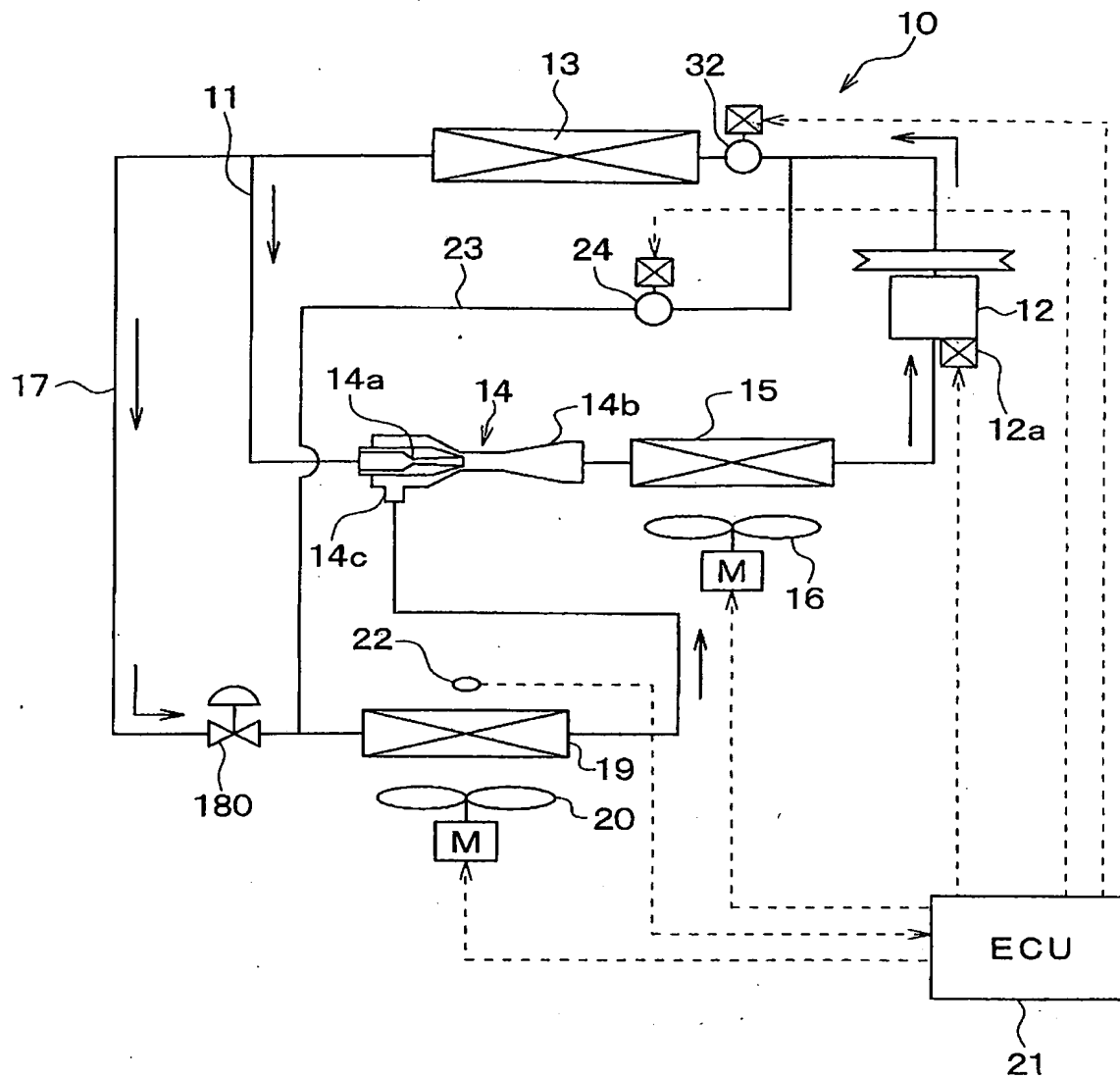
【図9】 [Fig. 9]



【図10】 [Fig. 10]

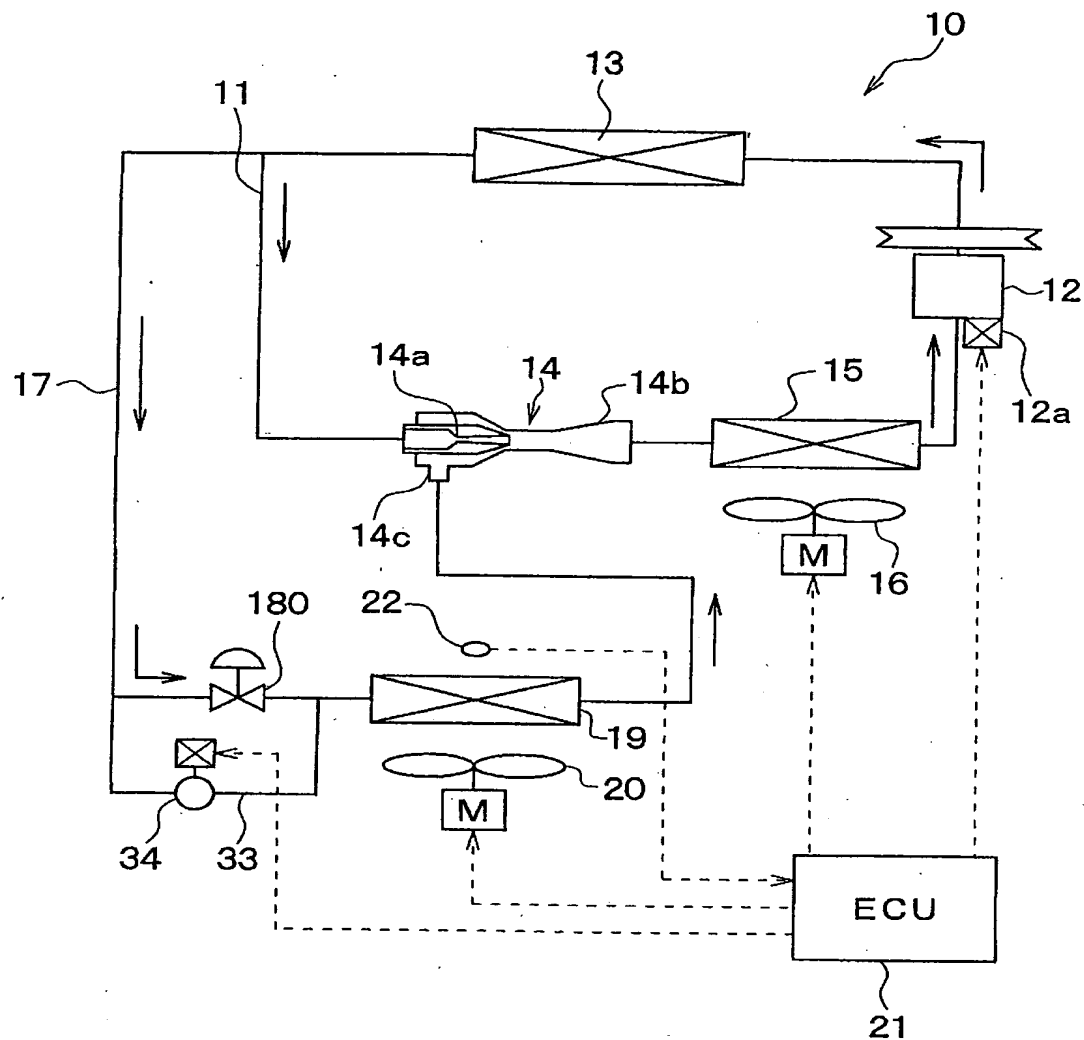


【図12】 [Fig. 12]

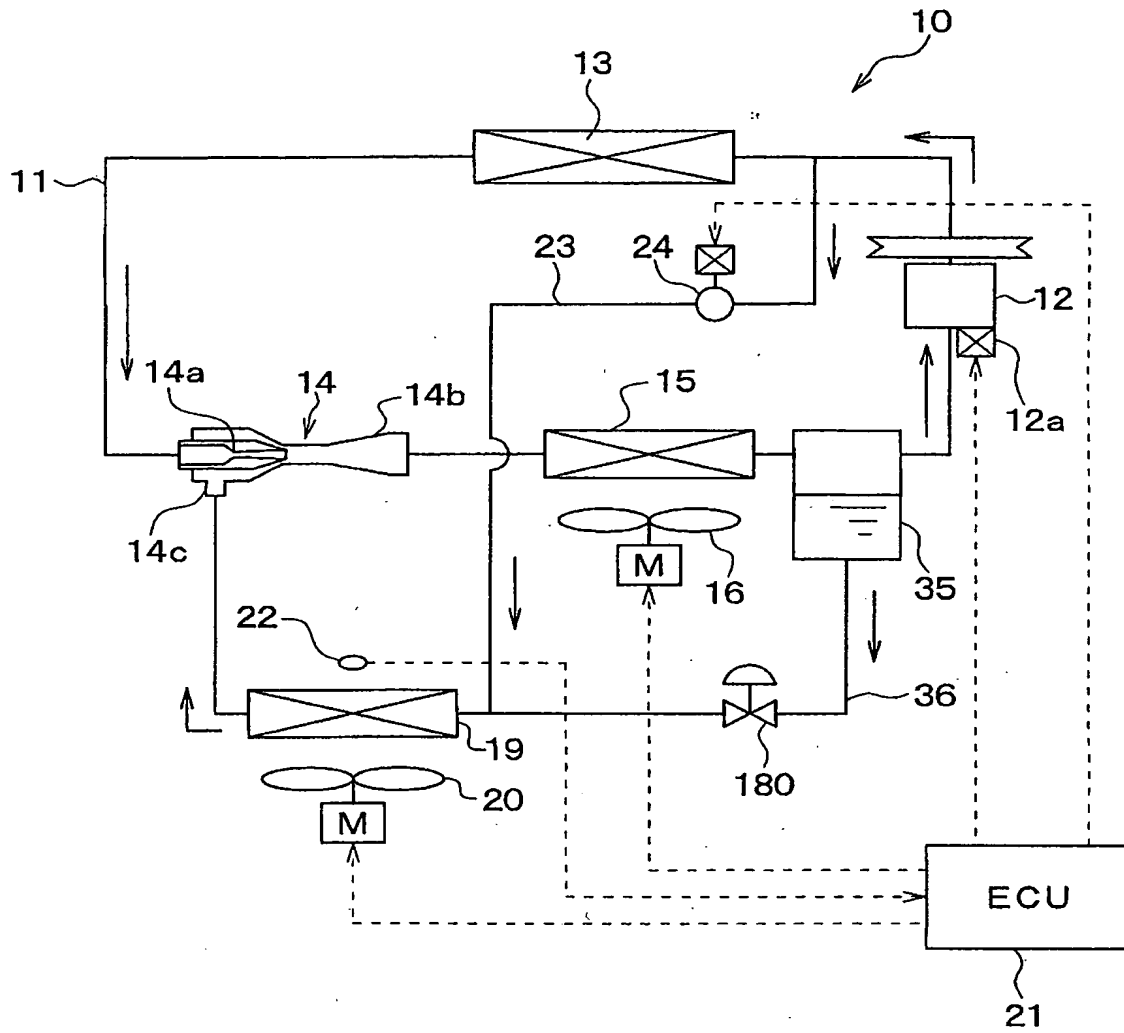


【図13】

[Fig. 13]



【図14】 [Fig. 14]



[NAME OF THE DOCUMENT] ABSTRACT OF THE DISCLOSURE

[ABSTRACT]

[OBJECT] It is an object of the present invention to obtain an evaporator defrosting function with a simple structure, in an ejector cycle using an ejector,
5 provided with plural evaporators.

[MEANS FOR SOLVING PROBLEMS]

An ejector cycle is provided with a first evaporator 15 that evaporates refrigerant flowing out of an ejector 14, a branch passage 17 that branches a flow of refrigerant between a radiator 13 and the ejector 14 and guides this flow of
10 refrigerant to a vapor-phase refrigerant suction port 14c of the ejector 14, a throttling mechanism 18 disposed in the branch passage 17, and a second evaporator 19 disposed downstream of the throttling mechanism 18 with respect to the flow of refrigerant. The throttling mechanism 18 is constructed to be provided with a fully opening function, and to fully open the branch passage 17 when the
15 second evaporator 19 is defrosted.

[SELECTED FIGURE] Fig.1